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B6J 520 525
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(54) KEYBOARD AND METHOD OF MANUFACTURING THE SAME

(71) We, CONTROL DATA CORPORATION, of 8100—34th Avenue South, Minneapolis, Minnesota, United States of America, a corporation of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement.—

This invention relates to keyboards and methods of manufacturing the same.

In a wide variety of electronics fields, it has been the general practice to utilize keyboards to perform various operations. The keyboards heretofore utilized have usually been of considerable size and have included mechanical keys and associated linkages. Although such devices have served the purpose, they have not proved entirely satisfactory under all conditions of service since the often complex mechanical arrangements are subject to fatigue and thus require peridoic repair or replacement. In addition, with the advent of the computer and the efforts to miniaturize, the use of such relatively bulky mechanical keyboards has not been entirely satisfactory. Furthermore, the mechanical keyboards are often characterised by contact bounce, thus requiring the design of additional circuitry to compensate therefor where only single activations of a circuit are desired, such as in stepping a computer through a program. In addition to requiring the design of compensating circuitry, such contact bounce present in mechanical keyboards may present a security problem since unique contact bounce signatures may enable the identification of a particular keyboard.

According to one particular aspect of the present invention, there is provided a keyboard comprising a plurality of conducting means in spaced relationship and secured to an insulating base member; pressure-sensitive material applied to at least a portion of each of said conducting means, said material having a resistivity which varies inversely with the applied pressure; common bus means affixed to said base member and spaced apart from said conducting means; and a conductive layer overlying said pressure-sensitive material, in electrical connection therewith and in electrical connection with said common bus means.

According to another aspect of the present invention there is provided a method of manufacturing a keyboard comprising the steps of forming and bonding an electrically conductive surface to an insulating base member; selectively eroding away said conductive surface to form a pattern of conductive pads and conductive paths; filling the cavities created by the erosion of the preceding step with an insulating material; selectively and partially eroding said conductive paths and said conductive pads to form cavities above the conductive paths and the conductive pads; filling the said cavities above the conductive pads with a pressure-sensitive material having a resistivity which varies inversely with the applied pressure; filling the said cavities over the conductive paths with an insulating material; and overlaying a conductive sheet over said pressure-sensitive material and said conductive paths to form an electrical connection between said pressure-sensitive material and the conductive paths which were not partially eroded.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 shows a plan view of the keyboard, partly broken away transversely;

Figure 2 illustrates an edge view of the keyboard taken on the line 2—2 of Figure 1 looking in the direction of the arrows;

Figure 3 illustrates the steps of manufacture of the keyboard; and

Figure 4 illustrates a plan view of the keyboard with the top layers of material removed.

With reference now to the drawings, where-

in like reference characters designate like or corresponding parts throughout the several views, there is shown in Figures 1 and 2 an insulating base member 10 made, for example, of glass. Bonded thereto in a grid-like configuration is conducting layer or common bus 12, which is formed by any one of a number of well known means on the insulating base member 10 and which is formed with a plurality of spaces 14 within which a plurality of conducting pads 16 are formed. These pads are also bonded to the insulating base member 10 in the same manner as the grid-like common bus 12. Electrically connected to each of the conducting pads is a respective conducting element 18 which passes through the insulating base member 10 to the bottom surface of the insulating base member and from there to the associated connectors and circuitry (not shown) with which the keyboard is to be operated. Each of the conducting elements 18 is bonded to the lower surface of the insulating base member 10 in a manner well known in the printed circuit art.

Thus, each of the conducting pads 16 is set apart from the common bus 12 by means of spaces 14 so that under normal conditions the conducting pads are electrically insulated from the common bus. Affixed to the upper surface 28 of each conducting pad 16 is a pressure-sensitive material 20 which is characterized by having an electrical resistivity which varies inversely with the application of pressure thereto. Various pressure-sensitive materials may be used, but for the purposes of this invention it is preferred that a pressure-sensitive paint be utilized which is manufactured by Clark Electronics, a Division of Advance Components Corporation of Santa Ana, California. Generally, a thinner coat will have a lower electrical resistance for any given applied pressure than a thicker coat and a larger contact area will have a lower electrical resistance than a smaller contact area. The electrical resistance of the paint for any given applied pressure, therefore, depends on the area, thickness and size of the contact area. As previously stated, other pressure-sensitive materials may be used, such as carbon-impregnated rubber materials, fibres impregnated with conducting particles, formed materials impregnated with conductive materials or finely divided or granulated carbon.

The pressure-sensitive material 20 is, thus, applied and allowed to strongly adhere to each of the conducting pads 16. Following the application of the paint, a conducting layer or sheet 22 is placed over the entire keyboard with at least one portion of the conducting layer or sheet 22 being placed in electrical contact with the common bus 12. Over the conducting layer or sheet 22 is then placed an insulating layer 24 of plastics or other material which is bonded to the conducting layer 22. The appropriate decalcomanias 26 are then affixed to the insulating layer 24 and over the appropriate conducting pads for indentification by the keyboard operator. In an alternative embodiment, the insulating layer 24 need not be used and decalcomania or key identification material can be placed directly on the conducting layer or sheet 22.

In the event that it is desired to shield the keyboard so as to provide security against undesired radiation, a layer of insulating material (not shown) could be placed over the conducting elements 18 on the underside of the base member 10 and the conducting layer or sheet 22 could then be extended to completely surround the keyboard to provide the necessary shielding.

In the operation of the printed circuit keyboard herein described, the board is first plugged into the appropriate connector and associated circuity. Each of the conducting elements 18 is, thus, placed in an operable position with respect to the associated circuitry (not shown) as is a common conducting element 18′ which is associated with and electrically connected to the common bus 12. If the keyboard operator desires to activate a particular one of the circuits associated with a specific one of the conducting pads 16, the appropriate key tab is located by means of the decalcomanias 26. Then, by the application of normal finger pressure to the top of the appropriate decalcomania, the pressure is transmitted to the pressure-sensitive material 20 associated with the particular conducting pad 16 located under the decalcomania selected. The increase of pressure on the pressure-sensitive material results in a reduction of the electrical resistance of the pressure-sensitive material and a concomitant reduction in the electrical resistance between the common bus 12 and the selected conducting pad located under the decalcomania. The electrical resistance of the pressure-sensitive material 20, when no pressure is applied, may be for example approximately 200 k ohms and may be reduced to approximately 10 ohms with the application of normal finger pressure by the operator. An electrical resistance range which is satisfactory for use with computer-type integrated circuits could vary from as high as 300 ohms when the key tab is depressed to as low as 5000 ohms when the key tab is not depressed. This reduction in the electrical resistance increases current flow between common bus 12 and the conducting pad 16 located under the decalcomania selected by the operator. This also enable the flow of current between the common conducting element 18′ and the conducting element 18 associated with the selected conducting pad 16 so that the function of the keyboard is thus performed. As previously stated, the electrical resistance of the paint or other pressure-sensitive material for any given applied pressure may be controlled by the amount of material used, etc.

so that the amount of pressure required to alter the resistance may also be varied depending upon the circumstances of use of the keyboard.

Figure 3 illustrates a series of manufacturing steps which will result in the construction of an apparatus of this invention. The cross-sectional views shown in Figure 3 are taken along a line 3—3 as illustrated in Figure 4. Step No. 1 of Figure 3 shows an insulated board 301 upon which is bonded a conducting sheet 302. The bonding process is accomplished according to any of the well-known printed circuit board deposition or electroplating techniques. Step 2 illustrates the same insulated board 301 and conducting sheet 302 after the conducting sheet 302 has been partially etched or eroded away to form a pattern of conductive pads and conductive paths. This etching or erosion process is accomplished according to any of the well-known etching or eroding techniques known in the printed circuit arts, e.g. using a photomask pattern and an acid etch. Step 3 illustrates the board of Step 2 after the etched cavities have been filled with an insulating material 303, such as epoxy resin.

Step 4 illustrates a further partial etching or eroding of the conducting sheet 302 to form cavities above the conductive pads and conductive paths. However, the outer edge 302a of the conducting sheet is not etched or eroded in this step. Step 5 shows the cavities above the conductive pads produced by Step 4 filled with pressure-sensitive material 304 of the type described herein, having an electrical resistivity inversely proportional to the pressure applied to its surface area. The depth of the cavities above the conductive pads produced by Step 4 is controlled to yield a pressure-sensitive material 304 thickness as shown in Step 5 that will provide an electrical resistance which is desirable for the particular electronic circuits which will be used in conjunction with the finished product. The cavities above the conductive paths produced by Step 4 are filled with an insulating material (not shown) such as epoxy resin. The conductive paths form the conductive paths between the conductive pads and the connector at one edge of the finished board.

Step 6 illustrates the addition of a conducting surface 305 over the entire board surface. Conducting surface 305 makes electrical contact with the outer edge 302a and also electrically contacts conducting sheet 302 via a path formed through pressure-sensitive material 304.

Optional Step 7 illustrates a further layer of insulating material 308 applied over the entire surface on top of the conducting surface 305. Insulating layer 304 contains identifying symbols for the conducting pads formed beneath it, or in addition, may provide a further insulator or electrical shield for the internal elements.

Figure 4 illustrates a plan view of the keyboard manufactured according to the steps of Figure 3, with the pressure-sensitive material 304 and printed circuit paths exposed for illustrative purposes only. The outer edge 302a is illustrated extending around the outer edge of the board and is electrically connected to a pin 402. Each of the conducting pads is individually connected to a connector pin, and the board is adapted so that it may be plugged into a connector plug for electrical connection to other external circuitry (not shown).

This invention thus provides an extremely inexpensive printed circuit keyboard which is adapted to be plugged directly into the circuits with which it is to operate. The keyboard provided by this invention is of small and compact size so as to eliminate the need for the often considerable amount of back-panel space now required by mechanical keyboards and is of rugged construction so as to eliminate the need for frequent maintenance or replacement. The keyboard also eliminates contact bounce.

Other changes and modifications can be made to the embodiment described herein and still remain within the scope of this invention. For example, a keyboard according to this invention could be constructed having the feature of illuminating each of the keys from behind the board surface by constructing each of the key pads in a doughnut-shaped configuration. In this embodiment the key symbols could be imprinted on a transparent or semi-opaque layer and a light mounted behind the board could be activated to illuminate the key symbol through the doughnut-shaped pad.

WHAT WE CLAIM IS:—

1. A keyboard comprising a plurality of conducting means in spaced relationship and secured to an insulating base member; pressure-sensitive material applied to at least a portion of each of said conducting means, said material having a resistivity which varies inversely with the applied pressure; common bus means affixed to said base member and spaced apart from said conducting means; and a conductive layer overlying said pressure-sensitive material, in electrical connection therewith and in electrical connection with said common bus means.

2. A keyboard as claimed in claim 1 in which said pressure-sensitive material is a pressure-sensitive paint.

3. A keyboard as claimed in claim 1 or 2 in which a printed circuit pattern is secured to said base member and is connected to said conductive layer.

4. A keyboard as claimed in any preceding claim including an insulating layer bonded to and covering said conductive layer.

5. A keyboard as claimed in any preceding

claim in which the resistance between the common bus means and each of said conducting means, respectively, is variable from a minimum of 5000 ohms with no applied pressure to said pressure-sensitive material to a maximum of 300 ohms with an applied pressure.

6. A keyboard as claimed in claim 1 including a plurality of conducting elements affixed to said base member and in respective electrical contact with said conducting means, the latter being in the form of pads, said common bus means and said conducting elements being adapted to be electrically coupled to a connector and associated circuitry so that applied pressure to said conductive layer over a said pad acts to lower the electrical resistance of said pressure-sensitive material on the said pad and to increase current flow between said common bus means and the respective conducting element associated with the said pad to operate on said associated circuitry.

7. A keyboard as claimed in claim 6 in which said conducting elements are affixed to said base member on the side thereof opposite from that upon which said pads are located.

8. A keyboard as claimed in any preceding claim in which said common bus means is a grid-like configuration.

9. A keyboard as claimed in any preceding claim in which said base member is composed of glass.

10. A keyboard as claimed in any preceding claim including selected decalcomania affixed to said conductive layer above at least one of said conducting means.

11. A keyboard as claimed in claim 6 in which the resistance between the common bus means and each of said conducting elements, respectively, is variable from a minimum of 5000 ohms with no applied pressure to said pressure-sensitive material to a maximum of 300 ohms with an applied pressure.

12. A keyboard as claimed in claim 6 or 11 in which said pressure-sensitive material is a pressure-sensitive paint.

13. A method of manufacturing a keyboard comprising the steps of forming and bonding an electrically conductive surface to an insulating base member; selectively eroding away said conductive surface to form a pattern of conductive pads and conductive paths; filling the cavities created by the erosion of the preceding step with an insulating material; selectively and partially eroding said conductive paths and said conductive pads to form cavities above the conductive paths and the conductive pads; filling the said cavities above the conductive pads with a pressure-sensitive material having a resistivity which varies inversely with the applied pressure; filling the said cavities over the conductive paths with an insulating material; and overlying a conductive sheet over said pressure-sensitive material and said conductive paths to form an electrical connection between said pressure-sensitive material and the conductive paths which were not partially eroded.

14. A method as claimed in claim 13 further comprising attaching an electrical connector to said base member and electrically coupling contacts on said electrical connector to selected conductive paths.

15. A method as claimed in claim 13 or 14 in which the erosion steps are accomplished by using a photomask pattern and an acid etch.

16. A method as claimed in any of claims 13 to 15 in which pressure-sensitive material is a pressure-sensitive paint.

17. A keyboard substantially as herein described with reference to and as shown in the accompanying drawings.

18. A method of manufacturing a keyboard substantially as herein described with reference to the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1.

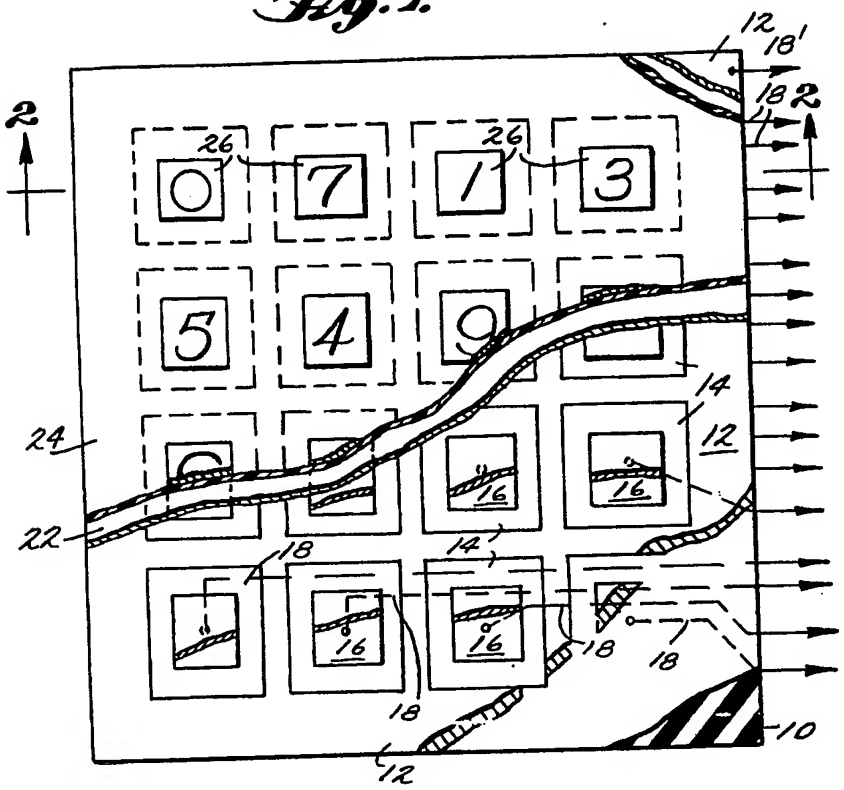
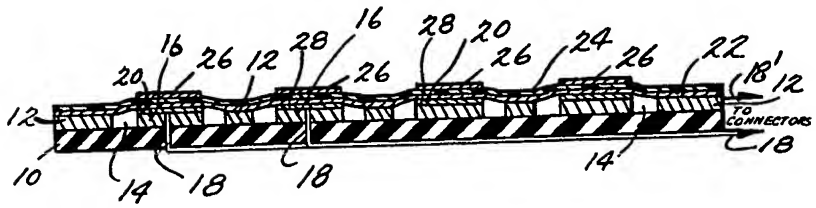


Fig. 2.



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Sheet 2

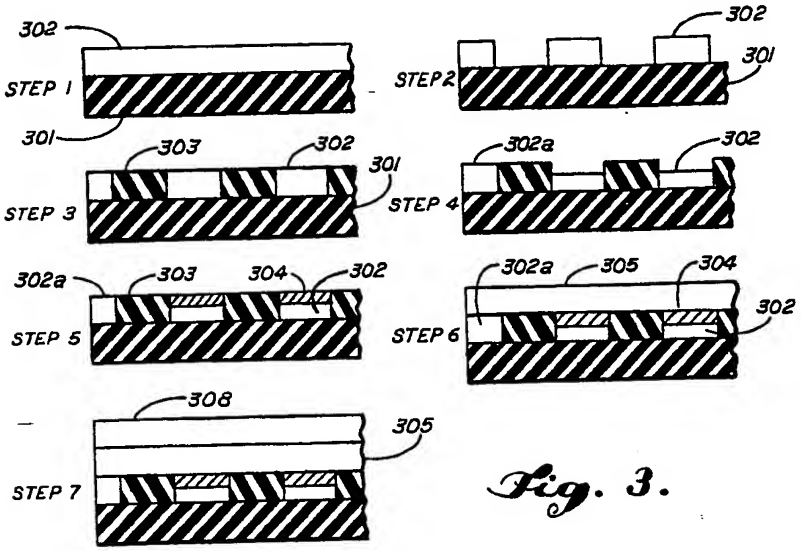

Fig. 3.

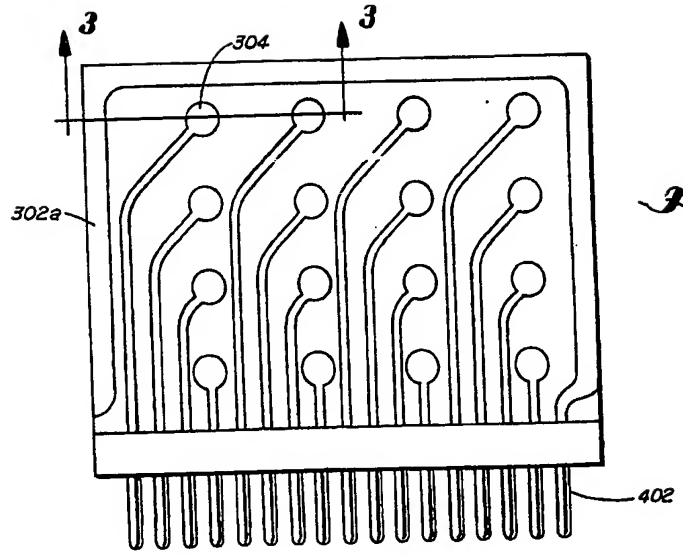

Fig. 4.